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TEACHING SAFETY SKILLS TO HIGH SCHOOL STUDENTS WITH MODERATE DISABILITIES

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Teaching students with disabilities to respond appropriately to potentially dangerous situations is a useful skill that has received little research attention. This investigation taught 3 students with moderate mental retardation to remove and discard broken materials (plates, glasses) safely from (a) a sink containing dishwater, (b) a countertop, and (c) a floor. A 4th student was instructed on the sink task only. A multicomponent treatment package was used to teach the skills. Simulated materials were used initially and were replaced with broken plates and glasses. A multiple probe design was used to evaluate the effectiveness of the treatment package. The results indicated that the treatment package was effective in teaching the skills. Data were collected 1 week and 1 month following the completion of training, and indicated mixed results. No student was injured during any phase of training. Issues pertinent to teaching safety skills to students with moderate disabilities are discussed.

DESCRIPTORS: time delay, response prompting, safety skills, chained tasks, simulation

There is very little research on teaching students with disabilities how to respond safely to potentially dangerous social and physical situations. In teaching domestic living skills, for example, many potentially dangerous situations are present, including handling noxious cleaning products, using sharp household implements (e.g., knives), and responding to events that pose the possibility for injury (e.g., broken glass). Cleaning up and disposing of broken materials (plates and glasses) during domestic skills instruction was the focus of the present research.

Current best practice in the education of students with disabilities suggests that several procedures may enhance skill acquisition and generalization. The use of time delay has been recommended because of its demonstrated effectiveness in teaching discrete tasks and task-analyzed chained tasks with few errors. Simulation has been recommended as a means of teaching useful skills in situations in which limitations of the education setting might preclude or otherwise restrict instructional oppor-

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tunities in the natural environment. Incorporating multiple examples of instructional stimuli also has been advocated to ensure that students respond successfully in the presence of materials that were not used during instruction.

This study combined the use of time delay, simulation, and multiple exemplar training to teach 3 students with moderate disabilities to remove and dispose of broken materials safely from three contexts. A 4th student received instruction on one task only. In using time delay procedures to teach task-analyzed chained responses, we replicated previous research (McDonnell, 1987; McDonnell & Ferguson, 1989; Miller & Test, 1989; Schoen & Sivil, 1989; Schuster, Gast, Wolery, & Guiltinan, 1988; Wolery, Ault, Gast, Doyle, & Griffen, 1990, 1991). However, the use of time delay to teach activities in which the risk of injury was present has not been documented. Similarly, simulation has many reported advantages (Browder, Snell, & Wildonger, 1988; Horner, McDonnell, & Bellamy, 1986; Neef, Lensbower, Hockersmith, DePalma, & Gray, 1990; Nietupski, Hamre-Nietupski, Clancy, & Veerhusen, 1986; Page, Iwata, & Neef, 1976), but its use as a deliberately programmed safety precaution has not been described previously. Thus, the current study (a) extended time delay research to domestic safety skills involving chained responses, (b) used simulation as a means of protecting students from danger during initial instruction, and (c) employed multiple examples of stimuli to facilitate generalized responding. The data of primary importance addressed the acquisition of the safe handling and disposing responses. Also, data were collected at 1 week and 1 month following training.

METHOD

Participants

Four students, aged 17 to 21 years and enrolled in a self-contained classroom for high school students with moderate and severe mental retardation and autism, were participants in this study. Measures of intelligence and adaptive behavior placed the participants in the moderate range of mental retardation. Two students (Steve and Julie) were receiving medication for the control of seizure disorders. Participants were selected after consultation with the classroom teacher, who identified students displaying unsafe responses to broken materials. Prior to their inclusion in the study, the participants were screened to assess prerequisite skills, which included (a) the ability to follow simple directions when given by the teacher and investigator, (b) adequate vision to discriminate broken from unbroken materials, (c) generalized motor imitation of a teacher's behavior when requested, (d) the ability to wait for up to 5 s for a prompt and to remain on task for periods of up to 30 min, (e) criterion performance on each task (i.e., wash dishes, clean a countertop, sweep floors), and (f) regular school attendance. Informed consent was obtained from the participants' parents before a student was included in the research project.

Materials and Setting

Two types of broken materials were used: (a) simulated broken materials (e.g., plastic cups, glasses, plates) and (b) actual broken glasses and plates. Multiple examples of the simulated and broken plates and glasses were used in the investigation. The selection of the training exemplars was guided by recommendations for teaching a general case (Horner et al., 1986). Training exemplars included a variety of plates, bowls, and glassware differing in color, size, shape, texture, and thickness. Additionally, common household items for dish-washing and floor-cleaning activities were used.

Teaching sessions were conducted in a one-to-one instructional arrangement in two classrooms of an integrated rural high school: (a) a home economics room with kitchen areas and (b) a traditional classroom. Instruction was conducted daily by a graduate student in special education. Students not receiving instruction were provided with other activities in an area away from the teaching activity.

Validation of Task Analyses

We analyzed the tasks of removing and discarding broken materials from a sink filled with dishwater, a countertop on which plates and dishes were placed, and a floor. A total of four teachers (two from home economics, two from special education) and the parents of the participants were asked if the proposed task analyses were acceptable safe practices for eventual classroom and home use. They were asked to suggest changes to resolve procedural and content discrepancies; these changes were incorporated into the task analyses used in the investigation. The task analyses are presented in Table 1.

Safety Precautions

Participation involved some degree of risk to the participants. That is, if broken materials were inadvertently mishandled, it was possible for a student to be injured. The potential for this risk was minimized by incorporating the following safety precautions: (a) Constant time delay procedures were used to minimize the risk of errors and possible injury, (b) the students wore latex gloves throughout all phases of the investigation, (c) the students were taught to dislodge the drain stopper with a kitchen utensil to avoid the risk of placing their hands into a sink containing broken materials not visible, (d) the students did not handle potentially injurious items until they had demonstrated proficiency in handling simulated broken materials at the criterion performance level (i.e., 100% unprompted correct responses during one session), (e) incorrect responses were interrupted by the investigator, (f) materials were not broken in the students' presence to avoid the risk of injury from stray glass and to eliminate a model of destructive behavior, and (g) a first-aid kit was present in the training setting during all phases of the investigation.

General Procedures

Three types of experimental conditions, probe, instructional, and follow-up, were used. Individual sessions were conducted daily and were completed within 20 min. During each session, a student performed a home-care activity in which broken items were present in (a) a sink filled with water, dishes, and glasses; (b) a countertop on which plates and glasses were placed; or (c) a floor. Before each session, broken items were placed in the work area. Sessions began with the general attention cue "Are you ready to work?" and a request to perform a specific task analysis (e.g., "Would you wash the dishes please?"). Upon seeing the broken materials, the student initiated the task appropriate for the situation.

Probe Procedures

Each student's performance on each task was assessed before instruction commenced in two types of probe trials, using only simulated broken materials. In a total-task probe trial, a student's ability to perform an entire task was evaluated. A total-task probe trial began with the teacher securing an affirmative response to the general attention cue and then directing the student to perform a task. At that time, the number of independently performed correct responses was scored. Students had 5 s to initiate each step of the task and 75 s to complete each step. A duration of 75 s was needed because students occasionally had difficulty putting on latex gloves, and particularly small pieces of broken material required more time to locate, remove, and discard. If the student failed to respond for 5 s or made an incorrect response, the session was terminated.

Immediately following completion of a total-task probe trial, a random-opportunity probe trial was conducted. These trials were conducted to determine whether the student could perform any steps of a task when they were presented in isolation. During these trials, the investigator presented each step of the task in a random order. To minimize the possibility that the instructor's arrangement of materials would inadvertently model correct performance of a step, the participant was asked to turn away from the activity for a brief period while the step was arranged. The participant was then asked to continue working. Students had 5 s to initiate each step of the task and 75 s to complete each step. If the student failed to respond for 5 consecutive seconds, assessment of the step was terminated.

Student performance in probe sessions was scored as correct or incorrect. Responses that conformed to the response definitions of the task analyses and were completed within 75 s were scored as correct. Steps not conforming to the response definition, no responses, or those exceeding the 75-s response interval were scored as incorrect. The students were thanked for their help when indicating they were finished or when the session was completed. For each student, probe sessions were conducted for a minimum of three consecutive sessions prior to the initiation of instruction on a specific task, or until data were stable.

Instructional Procedures

Each task was taught as a total task with a treatment package consisting of an orientation lecture, a pretask demonstration, and a constant time delay procedure. Each instructional session consisted of two trials. A trial was defined as the opportunity to perform every step of the task. Following completion of the first trial, the student was provided with a brief (i.e., 1-min) rest period. The task was arranged for the second trial.

Orientation lecture, pretask demonstration, 0-s time delay. The orientation lecture and pretask demonstration were given before the first instructional session. The orientation lecture provided a rationale for handling broken materials safely and lasted 2 min. During the pretask demonstration, the investigator modeled each step of the task in sequence and provided a verbal description of each response. A 0-s time delay trial was then conducted. During this trial, the investigator provided the general attention cue and delivered the task request. On each step, the controlling prompt was provided, the student imitated the investigator's behavior, and the investigator provided consequences.

Five-second constant time delay trials. The experimenter provided the attending cue and the task request, and waited 5 s for the student to make a response. If the student did not initiate the step within 5 s, the investigator provided the controlling prompt and the student imitated the investigator's behavior. Students were provided 75 s to complete each step. Consequences were provided after the investigator provided the controlling prompt or the student initiated a response before the prompt was provided. Beginning with the second and subsequent steps of the task, the 5-s delay was counted immediately after consequences were delivered for the previous step. Simulated materials were used during instructional sessions until a participant obtained 100% unprompted correct responses on all steps of the task. Thereafter, actual broken plates or glasses were used in the remaining instructional and follow-up sessions.

Student responses were scored in five categories. Unprompted correct responses were defined as a correct response within the 5-s constant time delay interval and completing the response within 75 s. Only unprompted correct responses counted toward criterion. A prompted correct response was scored if the student initiated the correct response within 5 s after delivery of the controlling prompt and completed it within 75 s. The controlling prompt consisted of the investigator verbally describing each step of the chain while simultaneously modeling the correct response. Unprompted errors were recorded when (a) a student's response did not conform to the response definition for each step (topography), (b) a student performed a step of the task in an order different from the specified sequence (sequence), or (c) a response was not completed within 75 s (duration). Prompted errors were scored if the student performed incorrectly after the delivery of the controlling prompt (topography), or if he did not complete the response within the 75-s response interval (duration). A no-response error was scored if the student failed to initiate a response within 5 s of the delivery of the controlling prompt. The investigator recorded the student's first response after the presentation of the task request or controlling prompt.

Students were provided with descriptive verbal praise (e.g., "Good, you used the fork to loosen the drain stopper") for each unprompted and prompted correct response. Incorrect responses were interrupted and resulted in the investigator stating, "Wait for me to show you if you don't know how to do it," and demonstrating correct performance of the step. Correction trials were provided until the student performed the step correctly. Criterion for

Table 1
Task Analyses for Sink, Countertop, and Floor Tasks

Wet sink	Countertop	Floor
1. Put gloves on.	1. Put gloves on.	1. Put gloves on.
2. Use utensil to dislodge drain stopper. Allow water to drain from sink.	2. Retrieve dust pan.	2. Get broom, dust pan, and brush.
3. Remove unbroken items, place to side out of sink.	3. Hold dust pan; place broken pieces from unbroken items into it. Place unbroken items in sink.	3. Tear small piece of paper towel and push any broken material on furniture into dust pan.
4. Rinse unbroken items in sink.	4. Tear piece of paper towel. Hold dust pan below counter surface; push broken pieces with paper towel into dust pan.	4. Empty dust pan into trash and throw away paper towel.
5. Bring trash can to sink area.	5. Empty dust pan into trash can. Use paper towel to wipe dust pan; throw paper towel into trash.	5. Move furniture out of area where broken material is on floor.
6. Grasp large pieces with hand and place in trash.	6. Rinse unbroken items in sink.	6. Use broom or dust brush to sweep the broken items into the dust pan.
7. Remove drain stopper; empty contents in trash can.	7. Remove drain stopper; empty contents in trash can.	7. Empty dust pan in trash.
8. Replace drain stopper.	8. Replace drain stopper.	8. Replace furniture.
9. Tear small piece of paper towel; push small pieces of broken material into drain stopper with paper towel. Throw away paper towel.	9. Tear piece of paper towel; push pieces of broken material into drain stopper with paper towel. Throw away paper towel.	9. Return broom, dust pan, and brush to storage area.
10. Remove drain stopper and empty contents into trash can. Replace drain stopper.	10. Remove drain stopper; empty contents in trash can. Replace drain stopper.	
11. Replace trash can.	11. Replace dust pan.	
12. Resume dishwashing activity.		

completion of instruction was one session at 100% unprompted correct responses on each of the following reinforcement schedules: continuous reinforcement, variable-ratio (VR) 3, and fixed-ratio (FR) 12, 11, or 9, delivered when all steps were completed.

Following instruction, the students' performance on each of the three tasks was evaluated in two follow-up sessions. These sessions were conducted at approximately 1 week and 1 month posttraining, and were similar to the individual total-task probe trials with two exceptions. First, students were provided with assistance if they waited for a prompt, errors were interrupted, and the incorrect step was completed for the student without feedback. Second, broken materials were used. These changes were included to facilitate assessment of the students' performance on all steps of the chain using broken materials.

Design and Reliability

A multiple probe design (Horner & Baer, 1978; Tawney & Gast, 1984) across participants and replicated across tasks was used to evaluate the effectiveness of the treatment package in teaching the participants to remove and discard broken materials safely. The sequence of experimental conditions began with a minimum of three consecutive probe sessions before instruction on a specific task, followed by teaching one task to criterion, probing the remaining tasks for generalization, and conducting two follow-up sessions following criterion performance on a skill.

Reliability data were collected on the dependent

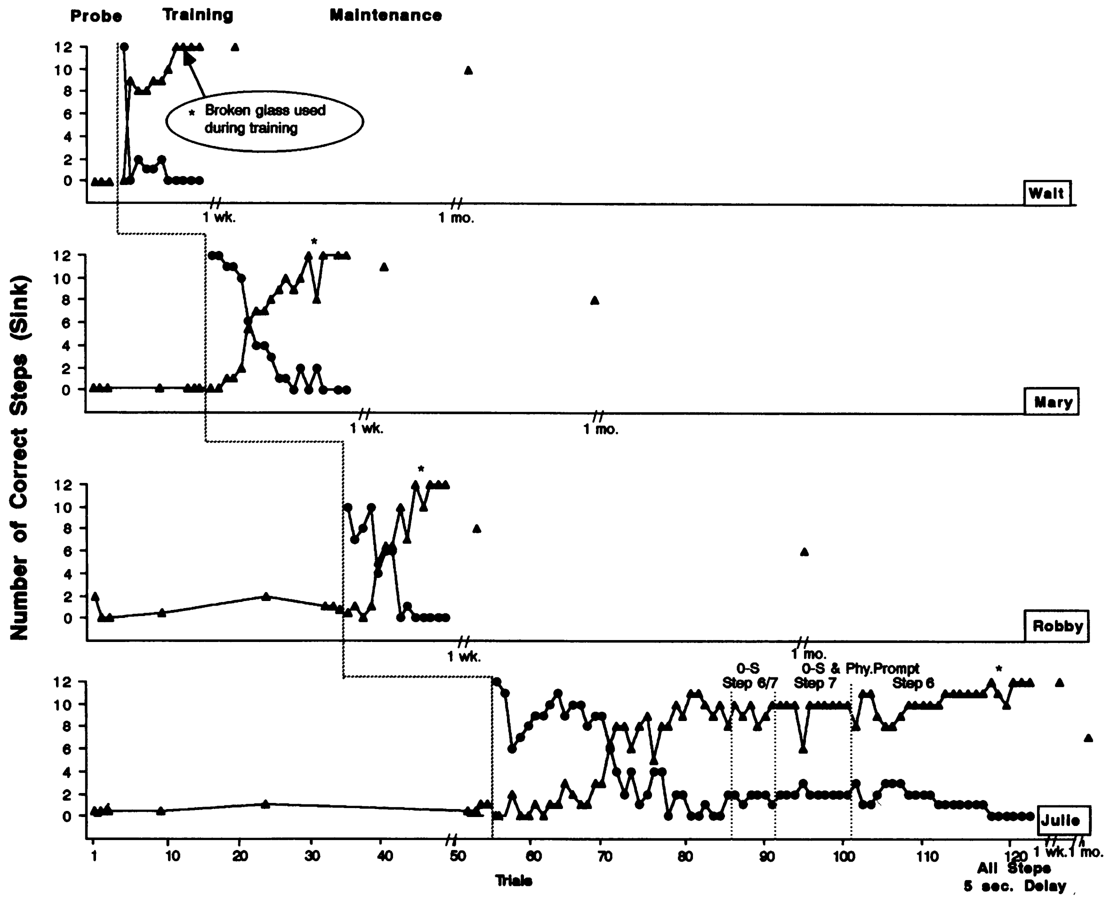

Figure 1. The number of correctly performed steps for the sink task during baseline probe sessions, training, and follow-up are represented by closed triangles. Prompted correct responses are represented by closed circles.

and independent variables. Reliability data on student performance were collected for 51% of the probe sessions, 44% of the instructional sessions, and 94% of the follow-up sessions by one observer. A point-by-point method of estimating interobserver agreement was used. Interobserver agreement during probe sessions was 99.7% (range, 89% to 100%), 99.7% for instructional sessions (range, 96% to 100%), and 100% for follow-up sessions.

Reliability of the independent variable (Billingsley, White, & Munson, 1980) was recorded at the same time as the data on student performance. The investigator's accuracy in providing the orientation lecture, the pretask demonstration, the general attending cue, the task request, the delay interval, the prompt, and the consequences was measured. Reliability estimates were 100% with two exceptions: Waiting during the delay interval was 98% (range, 79% to 100%) and providing consequences was 97% (range, 88% to 100%).

RESULTS

Effectiveness and Efficiency

The results of teaching 4 students to perform the sink task and 3 students to perform the countertop and floor tasks are presented in Figures 1 through 3, which show the number of correctly performed steps during baseline probe sessions and daily instructional sessions. All students performed inconsistently and at generally low levels during the baseline probe conditions. Only after training with the treatment package did the students acquire the safe handling and disposing responses.

Several procedural changes were necessary for Julie to reach criterion level performance on the

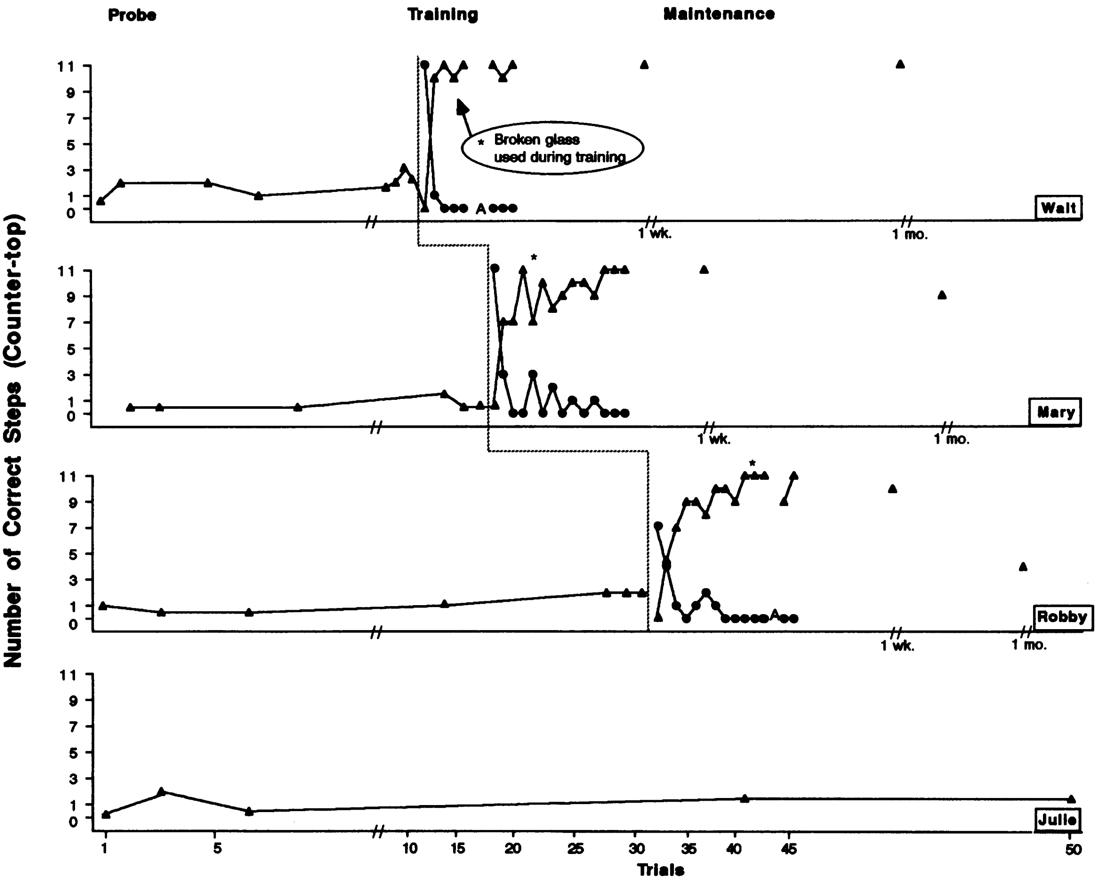

Figure 2. The number of correctly performed steps for the countertop task during baseline probe sessions, training, and follow-up are represented by closed triangles. Prompted correct responses are represented by closed circles.

sink task. After 32 instructional trials, she was not making unprompted correct responses on Steps 6 and 7 of the task. Therefore, six additional 0-s trials were conducted on those steps. Second, because Julie made two prompted errors at the 0-s delay, the controlling prompt was changed to a physical prompt on Steps 6 and 7 for the remainder of training on the sink task. The 5-s delay was reinstituted on Step 7 after 10 additional 0-s trials with the controlling physical prompt, and the 5-s delay was reinstituted on Step 6 after 18 additional 0-s trials with the controlling physical prompt. All subsequent trials remained at 5-s delay. The modifications were successful in establishing criterion level performance.

For the 3 students who received instruction on three tasks, instruction was completed in a mean of 12.5 trials (range, 5 to 18). Teaching the sink task required a mean of 14.3 trials (range, 11 to 18), the countertop required a mean of 12 trials (range, 8 to 14), and the floor required a mean of 11.3 trials (range, 5 to 16). Julie required 72 trials to reach criterion. For all students on all tasks (including Julie), a mean of 8.5% errors was made throughout the investigation (range, 2% to 15%), which was consistent across tasks. A total of 177 errors were made. Of these errors, 148 (84%) were unprompted and 29 (16%) were prompted. Topographical errors (n = 77) and sequence errors (n = 71) accounted for all unprompted errors. Of the prompted errors, all were topographical.

Follow-Up

Follow-up sessions were scheduled at approximately 1 week and 1 month following the completion of training on each task. On the sink task

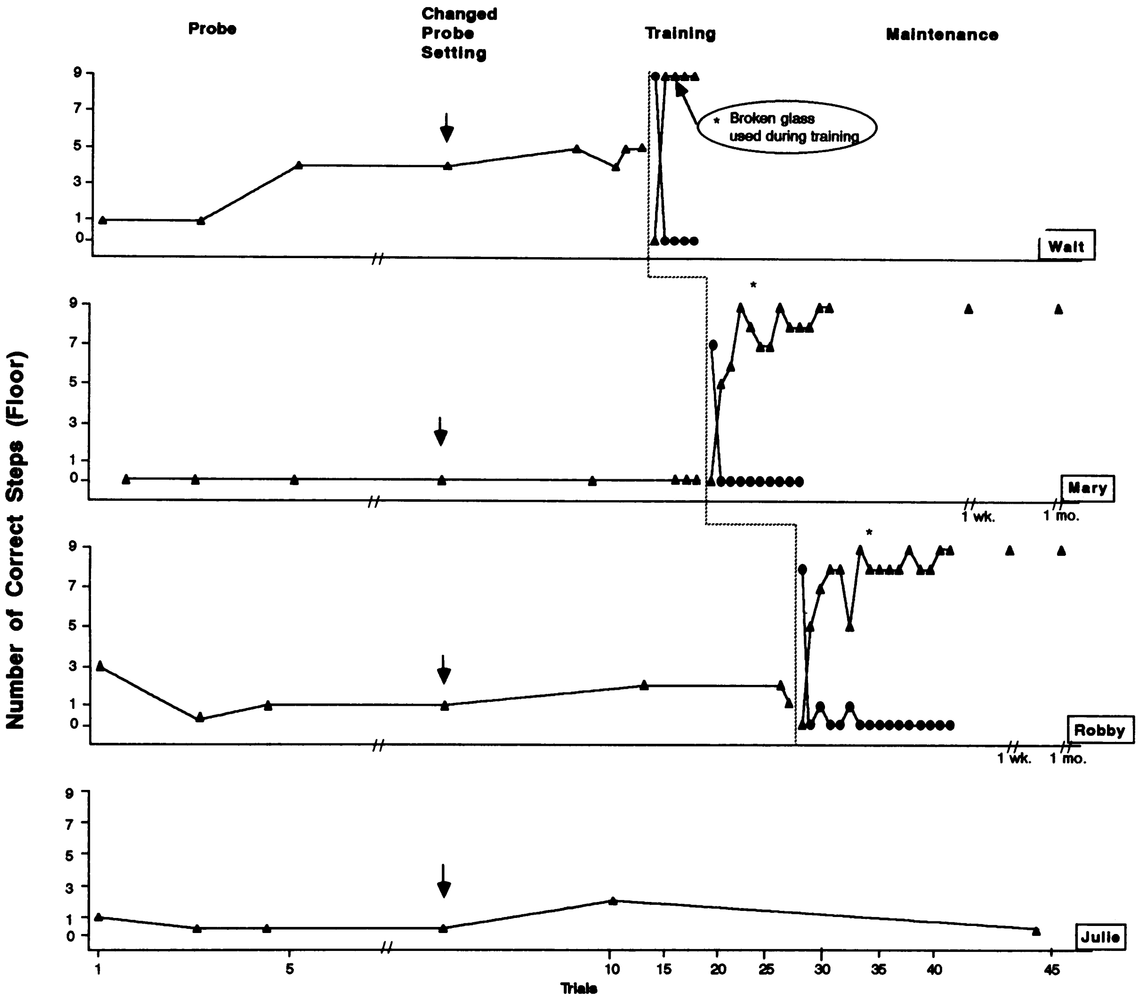

Figure 3. The number of correctly performed steps for the floor task during baseline probe sessions, training, and follow-up are represented by closed triangles. Prompted correct responses are represented by closed circles.

at 1 week posttraining, Walt and Julie performed at 100% correct unprompted responses. Mary performed 11 of 12 steps correctly, and Robby performed 8 of 12 steps correctly. At 1 month posttraining, all students made errors. On the countertop task at 1 week posttraining, Walt and Mary performed at criterion levels. Robby performed 10 of 11 steps correctly. At 1 month posttraining, Walt remained at criterion, and Mary and Robby made errors on several steps. On the floor task at 1 week posttraining, Mary and Robby performed at criterion levels. Walt was unavailable for study. At 1 month posttraining, Mary and Robby maintained performance at 100% unprompted correct responses.

DISCUSSION

The results of this investigation indicated a treatment package consisting of an orientation lecture, pretask demonstration, and a 5-s constant time delay procedure was effective in teaching the skills of removing and discarding broken materials from a sink filled with dishwater, plates, and glasses, a countertop that contained plates and glasses, and a floor. Analysis of the follow-up data at 1 week posttraining indicated that 3 of 4 students could perform the sink task, 2 of 3 students could perform the countertop task, and the 2 students who were assessed could perform the floor task. At 1 month, the data were mixed. Walt performed at criterion on the countertop task, and Mary and Robby remained at criterion on the floor task. However, Mary and Robby could not complete the sink or countertop task without assistance, and Julie required assistance on the sink task. Selecting instructional stimuli that sample the range of variation of common household plates and glasses appeared to facilitate generalized performance across instructional stimuli. The participants had no difficulty handling the many types of broken plates and glasses they encountered. All training stimuli were handled safely and proficiently. However, because this investigation did not directly assess generalization either across untrained stimuli or the variety of settings in which broken materials might be encountered, these findings must be viewed cautiously.

This investigation used a treatment package in teaching the participants safety skills during domestic skills instruction. Thus, it is not possible to infer a causative role to any single component of the independent variable. The use of one or a combination of the components could have produced results similar to those obtained in this investigation. The role of specific independent variables in teaching safety skills awaits future research. It is interesting to note the similarity of the present investigation with a recent study that taught safety skills to students with moderate disabilities (Spooner, Stem, & Test, 1989). Spooner et al. used a treatment package consisting of a group discussion and what was described as a "replication of Matson's (1980) social modeling procedure" (p. 344), which involved teacher modeling, student practice, and probe sessions. Given the importance and complexity of teaching domestic safety skills to students with disabilities, a treatment package may well be preferred for teaching these types of skills rather than one of the independent variables presented alone.

We replicated the work of other investigators in using constant time delay to teach chained tasks to students with moderate and severe disabilities (McDonnell, 1987; Miller & Test, 1989; Schuster et al., 1988; Wolery et al., 1990, 1991). In those investigations, error rates were generally low; our results are consistent with those reports. Teaching skills with the potential to cause harm to participants involves many considerations and precautions, one of which is attempting to minimize errors. Employing near-errorless response prompting procedures such as constant time delay either alone or in concert with other procedures, as in the present investigation, may represent a safe and effective method of teaching other skills in which student errors could prove injurious. Thus, this investigation has both practical and research implications. First, students were protected from injury, in part, because the procedure (i.e., time delay) reduced the probability of errors; teachers providing instruction in domestic safety skills should adopt such procedures. Second, time delay research was extended to a new and important skill domain (i.e., safe handling of broken materials). Its application with other skills presenting the possibility of injury should be investigated.

For Julie, the sink task was an apparently complex and difficult task. In cases such as these, the use of progressive time delay can be recommended (Snell & Gast, 1981). Progressive time delay may have enhanced skill acquisition by providing a slower and less abrupt transfer of stimulus control and reducing the possibility of errors due to the initial small response interval. Constant time delay was used because of her previous successful acquisition of other skills (e.g., making cookies).

Several authors have commented on the use of simulations to teach functional and generalized skills (Browder et al., 1988; Horner et al., 1986; Nietupski et al., 1986; Page et al., 1976). One of the principal advantages of simulation training is that students can be protected from risks associated with potentially dangerous activities (e.g., Page et al., 1976). We used simulation to ensure the students had learned to handle broken materials safely when the risk of injury was minimal before exposing them to actual broken plates and glasses. This approach to skill training ensures that students' eventual exposure to potentially injurious materials is carefully monitored by their teachers.

The success of these training data is mitigated by the inconsistent performance of the participants during the follow-up sessions. Close inspection of these data indicate no apparent trends either within or across participants. Several explanations could account for their poor performance. First, the performance criterion of one session of 100% unprompted correct responding on each of three reinforcement schedules was probably inadequate. In retrospect, it may have been beneficial to have extended training for several additional sessions to ensure fluent posttraining performance. A performance criterion identical to the one used in this study was used by Schuster et al. (1988). These authors reported good performance over a 3-month posttraining period. In this study, we were hampered by the need to complete the research by the end of the school year and, as a result, maintenance was not programmed. Future research in this area might ensure high levels of posttraining performance by teaching personnel in the setting in which the research was conducted to provide opportunities for the skills to be practiced regularly and retrained if necessary. Second, the domestic safety skills were not incorporated into the participants' regular activities at home or in other settings. Given our time constraints, we were not able to provide training to relevant persons in the students' natural environments. Posttraining performance might be enhanced by communicating with relevant persons in the students' environments and informing them of the types of skills being taught and the competencies of the students as a result of such training.

It might also be questioned to what extent teaching students task-analyzed skills in a fixed sequence affects posttraining performance (cf. Miller & Test, 1989; Schuster et al., 1988; Wolery et al., 1990). The number of sequence errors at the 1-month follow-up probe sessions raises concerns that had the students been evaluated with a more functional criterion (i.e., was the student injured during the task, and was the broken material removed from the setting?), they would have performed better. Teaching the skills in a fixed sequence was justified by the desire to teach the skills without introducing undue risks. Based on the training results, we were clearly overcautious. Subsequent research may clarify this issue by including an additional probe trial in which students wear protective equipment and perform the task. The student would then be interrupted only when the risk of injury was imminent. The student's performance, when evaluated on a functional criterion, could be combined with the results of total-task and random-opportunity probe sessions to determine candidates for training.

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